

Duke University

DURHAM
NORTH CAROLINA
27708-0281

DEPARTMENT OF BIOMEDICAL ENGINEERING
ROOM 136, PRATT SCHOOL OF ENGINEERING
BOX 90281

TELEPHONE: (919) 660-5451
FAX: (919) 660-5362
EMAIL: rwn@duke.edu

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RE: Docket No. NHTSA-03-15351

FMVSS 213: Final Rule

Our research laboratory has been studying the mechanisms of catastrophic neck injury for over 15 years. We have reviewed the Final Rule on the Child Restraint Systems Standard and have serious concerns regarding the assertion that HIC36 somehow provides a measure of neck injury risk. As written, the final rule offers no biomechanically based safeguards against catastrophic neck injury and any implication that it does should be removed. For example, on page 37649, it is stated that HIC36 will, “*capture the risk for neck injury indirectly*”. This is not true of HIC36, or of any HIC calculation for that matter. Resultant head acceleration, does not describe the injury producing forces and moments experienced by the neck. Even under the special circumstances in which no head contact occurs (which cannot be assured in a performance standard of future designs) head resultant only describes upper neck resultant and does not determine the components of neck force or neck moment (e.g. neck tension). And yet, the components of neck force and neck moment are each associated with unique neck injury tolerances and unique neck injury mechanisms. These points are readily illustrated by a Free Body Diagram of the head in an acceleration field with and without contact. Using a power relationship of acceleration (as the HIC does) further distances an injury metric from a biomechanically meaningful measure of neck loading and neck injury risk, because Newton’s equation’s of motion do not have such a power relationship.

From an epidemiologic perspective, both HIC and neck injury risk are positively correlated with crash severity, and thus likely have some modest correlation to each other. It is mechanistically unsound however to suggest, on the basis of that correlation, that setting a HIC criterion to a particular level will provide an assurance of the prevention of catastrophic neck injury under the generalized loading that can occur between a child occupant and child safety seat. Indeed, our published work and the works of others show that head and neck injury generally occur by different mechanisms at different times during the occupant loading (Myers and Winkelstein, 1995; Nightingale et al., 1997). It is of little surprise then that these research studies show poor correlation between HIC and neck injury and we are not aware of any meaningful biomechanical data that suggests otherwise. Thus, the statement that “*the longer measurement window associated with HIC36, as opposed to HIC15, will provide reasonable assurances that a child’s neck will not be subjected to excessive forces in a crash*” is unfounded and dangerous. We do accept that it may be scientifically premature to include Nij or

other neck injury metrics in the new standard for this age group; however, the agency, the manufacturers, and the public should not be misled by a VSS standard to assume that a HIC metric offers any assurances against neck injury.

Sincerely,

Roger Nightingale, Ph.D.
Associate Research Professor
Department of Biomedical Engineering
Department of Surgery

Barry S. Myers M.D., Ph.D.
Anderson-Rupp Professor of Biomedical Engineering and Director of Graduate Studies
Department of Biomedical Engineering
Department of Biological Anthropology and Anatomy
Division of Orthopaedic Surgery

References:

Myers, B.S., Winkelstein, B.A., "Epidemiology, Classification, Mechanism, and Tolerance of Human Cervical Spine Injuries". Critical Reviews in Bioengineering, 23(5&6): 307-410, 1995.

Nightingale, R.W., McElhaney, J.H., Camacho, D.L.A., Winkelstein, B.A., Myers, B.S., "The Dynamic Responses of the Cervical Spine: The Role of Buckling, End Conditions, and Tolerance in Compressive Impacts". Society of Automotive Engineers, J. Passenger Cars, 1997.